Name of Organization: University of Illinois at Chicago

Type of Organization: College or University

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Project Title: Nitrogen Pollution Promotes Invasion of Natural Habitat

Project Category: Exotic Species

Rank by Organization (if applicable): 0

Total Funding Requested ($): 81,446 **Project Duration:** 1.5 Years

Abstract:

Exotic species are a major threat to natural communities. As in many ecosystems worldwide, native plant species in the Great Lakes ecoregion have been increasingly replaced by exotic species. Programs such as Chicago Wilderness highlight the vulnerability of local ecological communities to invasion. While all the causes of rapid species composition changes in the Great Lakes region are not fully understood, there is a general recognition that anthropogenic activities are a major catalyst. Human activities associated with the decline in biodiversity include habitat fragmentation, suppression of fire and alteration of the hydrologic cycle. Recently it has become clear that chronic deposition of atmospheric nitrogen (N) may also be a key factor in promoting the replacement of native species by the invaders. The N deposition problem is particularly acute in the vicinity of urban areas such as Chicago where nitrate levels in the atmosphere could be as much as one hundred times higher than the background. Our project will demonstrate that, 1) invasive, exotic species are more abundant in urban natural areas than in rural ones, and 2) that the mechanism for such increased dominance of exotic species is related to higher atmospheric N input in urban compared to rural areas. We will demonstrate these ideas using both field studies of natural areas and in constructed communities at the University of Illinois at Chicago. Field studies will include cover of fourteen exotic plants and soil and plant N data from eight sandy soil sites along the urban to rural gradient of N deposition. The increased dominance of exotics will be demonstrated in artificial communities. Three of the most invasive exotics (buckthorn, garlic mustard and purple loosestrife) will compete with three native species under different levels of nitrogen addition. These artificial communities will demonstrate the impact of atmospheric N pollution in promoting invasive species in the Great Lakes ecoregion.

Geographic Areas Affected by the Project

States:

- [x] Illinois
- [x] Indiana
- [ ] Michigan
- [ ] Minnesota
- [ ] New York
- [ ] Pennsylvania
- [ ] Wisconsin
- [ ] Ohio

Lakes:

- [ ] Superior
- [ ] Huron
- [x] Michigan
- [ ] Erie
- [ ] Ontario
- [ ] All Lakes

Geographic Initiatives:

- [x] Greater Chicago
- [ ] NE Ohio
- [ ] NW Indiana
- [ ] SE Michigan
- [ ] Lake St. Clair

Primary Affected Area of Concern: Grand Calumet River/IHC, IN

Other Affected Areas of Concern:

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area: Chicago Wilderness

Other Affected Biodiversity Investment Areas:

Problem Statement:

Throughout the world native plant species have been increasingly replaced by the exotic species. The problem is worst in urban areas including those metropolitan areas along the Great Lakes. There is a general recognition that anthropogenic activities are a major catalyst promoting the invasion of exotic species. Industrial regions of the world are currently experiencing increased levels of atmospheric nitrogen (N) deposition. Atmospheric N is a by-product of human activities associated with farming and/or combustion of fossil fuel. In the Chicago region, atmospheric N deposition is now 12 to 25 Kgh-1yr-1 (NADP 2000). This amount is two orders of magnitude greater than what is expected from areas remote from air pollution (Jefferies and Maron 1997). Plant growth is often limited by N availability (Schlesinger 1991, Vitousek 1997) and in many ecosystems chronic addition of N can profoundly effect species composition and biodiversity (Tilman 1993, Weddin and Tilman 1996). The reason for this shift in species composition is that different species respond differently to increased availability of N. Plant species vary widely in their capacity to absorb and utilize soil N (Jefferies and Maron 1997). Invasive exotic species typically respond to increases in nitrogen availability. We wish to demonstrate that the abundance of invasive exotics is greater in natural areas with higher atmospheric nitrogen deposition and that nitrogen additions to experimental communities favors exotic over native species.

Proposed Work Outcome:

The invasive species that will be examined here include four woody shrubs, Rhamnus cathartica, Rhamnus frangula, Lonicera and Rosa multiflora, and ten herbaceous species, Alliaria officinale, Cirsium arvense, Cirsium vulgare, Daucus carota, Glechoma hederacea, Leonurus cardiaca, Lythrum salicaria, Phalaris arundinacea, Rumex acetosella and Verbascum thapsus. Relative dominance of these species at each site will be assessed using percent cover in 1 m2 quadrates replicated twenty times at each site. The quadrates will be on a transect at least 50 m in from the corner of each property. We will also determine percent cover for legumes to evaluate how their abundance changes in this gradient. Legumes, as a functional group, are often sensitive to increased availability of N and are expected to decrease in abundance in areas with higher nitrogen deposition.

Using actual N deposition (total dry and wet deposition of NO3- and NH4+) data of five sites (Dunes, IN, Purdue, IN, Shabona in Dekalb County IL, Argonne, IL and Lake Geneva, WI) from National Atmospheric Data Program (NADP), we have selected a set of study sites that represent a decreasing gradient of N deposition from urban to rural areas on similar soils. For example, between 1989 and 1998, the Indiana Dune site received a cumulative deposition of 213 Kg ha-1compared to 170 kgha-1 received at the Purdue site. The sites we propose to study are concentrated in Indiana. They

include Miller Beach(U), Ivanhoe(U), Hoosier Prairie(U), German Methodist Prairie(U/R), Conrad(R), and Tefft(R) in Indiana, Illinois Beach State Park(U/R), and Jurgensen's Woods(U) in Illinois. We are currently seeking permission from owners of these sites and would welcome suggestions from EPA should the agency feel that the strength of this project will be improved by inclusion of other sites. The field data will be collected between 15 May and 30 September.

For the statistical analysis, the percent cover of the invasive species or the legumes will be used as the dependent variable with the estimated (from NADP data) N deposition rate as independent variable. Other variables that will be used in the statistical analysis include urban versus rural as categorical variables and a landscape measure of degree of urbanization. We expect to find that sites with greater N deposition i.e., those closer to urban centers have a greater abundance of invasive species, but lower abundance for legumes. If these analyses indicate a statistically significant relationship, further analysis will look at frequent individual exotic species. It is possible that only some exotic species are promoted by high nitrogen deposition.

The competition studies will be conducted outside the greenhouse facilities of the UIC using a mixed-species communities grown in 70-L containers filled with river-washed sand. The target species for these experiments will be three invasive species, European buckthorn (Rhamnus cathartica), purple loosestrife (Lythrum salicaria), and garlic mustard (Alliaria officinale) competing against three native species, little bluestem (Andropogon scoparius), purple prairie clover (Petalostemum purpureum) and white snakeroot (Eupatorium rugosum). There will be six species-mix composition treatments and four N addition treatments with a replication number of two. Each species-mix composition will include all the species listed above except one. The nitrogen treatments will be chosen so that they mimic deposition rates of 10, 20, 30 and 40 Kg ha-1 added to the containers on a weekly basis. The composition of the added N will also be designed so it will mimics the nitrate to ammonium ratio of the atmospheric deposition. The communities will be grown for an entire growing season under, otherwise, natural conditions. At the end of the growing season, competitive strength for each species will be determined by comparing their total dry biomass. Using our own Elemental Analyzer we will also determine tissue N concentrations for each species. This will allow us to determine if changes in plant growth and competitive ability are correlated with their ability to acquire N.

Project Milestones:	**Dates:**
Project Start	07/2000
Survey Cover in natural areas	09/2000
Analyze Cover of Exotics	12/2000
Plant Experimental Communities	05/2001
Resurvey natural communities	08/2001
Harvest experimental communities	09/2001
Data Analysis	11/2001
Project End	12/2001

☐ Project Addresses Environmental Justice

If So, Description of How:

This study will involve ecological work in urban areas and is explicitly spatial. Such data are likely to be of interest to those concerned with environmental justice, but our project will not explicitly address issues of environmental justice.

☒ Project Addresses Education/Outreach

If So, Description of How:

The University of Illinois at Chicago is one of the major educational institutions in Chicago. Support for graduate students and faculty research inevitably spills over to influence the environmental outlook of graduate and undergraduate students. We look forward to presenting the results of this work at scientific, educational and environmental meetings.

Project Budget:

	Federal Share Requested ($)	Applicant's Share ($)
Personnel:	41,942	12,606
Fringe:	3,502	3,402
Travel:	1,000	2,000
Equipment:	0	0
Supplies:	6,000	2,000
Contracts:	0	0
Construction:	0	0
Other:	0	0
Total Direct Costs:	52,444	20,008
Indirect Costs:	29,002	0
Total:	81,446	20,008
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Other than the funding from the University of Illinois at Chicago that we have described in the match section, we do not currently have a funding commitment from any other organization. We expect to seek funding for related projects that are more oriented to NSF or DOE research questions.

Description of Collaboration/Community Based Support:

The Indiana Chapter of The Nature Conservancy
The Forest Preserve District of Cook County
The State of Illinois Division of Natural Resources
The Indiana Dunes National Lake Shore (Department of Interior)